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LAMBDA

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LAMBDA

by

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Thesis

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Dedication

To Michelle Habeck, who has always encourage me to pursue my passions and interests.

To Jason Buchanan, who taught me to have trust in my own strengths and abilities as an artist.

And lastly to my family, without them to nurture my younger self this thesis would never have been conceived or possible.

Thank you, all.

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Abstract

LAMBDA

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LAMBDA was an exploration of science and art in two components: a performance-lecture and an art installation. This project asserted that performance and art are effective methods of delivering scientific information to a general audience.

The first component was a solo performance-lecture that used lights, projection, costumes, props, and sound in a hybrid classroom space. The performance-lecture covered the topics of light, the Aurora Borealis, gravitational lensing, and the cosmic microwave background. The art installation used light emitting objects to visually represent the gravitational disturbances that exist within a section of space-time.

Table of Contents

LIST OF ILLUSTRATIONS

CHAPTER I: INTRODUCTION

Explanation of Project

This thesis project has two components. It has a performance-lecture(1), and an art installation(2). The performance-lecture and the installation have the goal of communicating science to a mass audience.

Thesis statement - Performing Science

Can the passage of scientific knowledge, of any subject matter, from one person to another be a performative event? I assert that the passage of scientific knowledge and information from one person to another can be both entertaining and informative. The usage of live performance to spread the information to those not directly involved with the scientific research allows for a more engaging form of information dissemination. I will approach this assertion by creating a scientific performance-lecture that will be preformed to a live audience, and through the creation of a light emitting art installation that will be installed into a public space.

Performance-Lecture - LAMBDA

I will create a performative scientific lecture that employs the use of imagery, enthusiasm, and humor through the events of a story based upon a true character. All this shall be done while presenting factually accurate data and information. The performance-lecture will explain three astronomical phenomena involving light. The phenomena are the aurora borealis, gravitational lensing, and the cosmic microwave background radiation. I will devise, create, and preform in an original performative work using scenic, lighting, costume, sound, and projection elements.

The goal of the performance-lecture is to evoke an audience to engage and form a relationship with the material, and to gain an understanding or appreciation of the current theoretical models of certain astronomical phenomena. A point of relation and a point of attachment is necessary to draw the audience in and give the material context in those

whose lives have pointed their directions outside of those related to the scientific knowledge surrounding the above listed phenomena.

Installation - Gravity Wells

The art installation will use light emitting objects to demonstrate the multiple gravitational disturbances that can exist over a volume of space-time. This installation will be much more subtle in the presentation of scientific information, leaving it up to the viewer to make their own meaning.

Explanation of Cosmic Photonic Phenomena

I chose the following three topics based on several factors. The first factor is my own personal interest in the phenomena. Secondly they were chosen on how best a short narrative that flows from one topic to another. And lastly, I tried to pick topics that an audience may not have had exposure to previously, making this all new information.

AURORA BOREALIS(NORTHERN LIGHTS)

The Aurora Borealis is an interaction between coronal matter ejected by the sun, the Earth's magnetosphere, and the Earth's atmosphere. The coronal matter, usually in the form of hydrogen ions and electrons, is ejected by the sun and gets caught along Earth's magnetic field lines. The earth has a North and South Pole. Magnetic field lines extend out from oone pole, arc around the earth and connect with the opposite pole. The coronal matter caught along the field lines are directed to the north and south poles. As these charged particles begin to travel into Earth's atmosphere, a thick blanket of gases that encompasses the Earth, and they interact with atoms and molecules in our atmosphere. As the atoms and molecules collide they become energized and excited. The light emitted is the energy released as the atoms de-excite. We call this the aurora borealis(northern lights) in the northern hemisphere or the aurora australis(southern lights).

Illustration 1: The Aurora Borealis (Northern Lights)

GRAVITATIONAL LENSING

Gravity has the ability to pull and have an observable effect on particles of light. Albert Einstein's equation $E=MC^2$ states that mass and energy are interchangeable. Energy will therefore still feel the effects of gravity. Light is a form of energy. The light from distance objects can become lensed and bent as the particles of light interact with gravitationally massive objects such as stars and galaxies. This effect is similar to a glass lens here on earth that can refract and magnify light. A light ray can take a very winding path as it travels through space and time and can be lensed many times by many gravitationally massive objects.

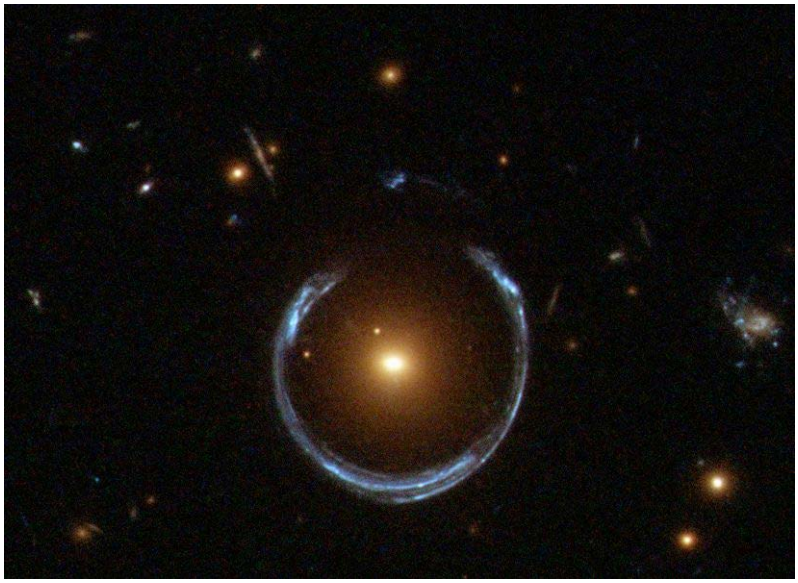

Illustration 2: An example of gravitational lensing.

COSMIC MICROWAVE BACKGROUND(CMB)

The spectrum of light that humans are capable of seeing is a very small section of the full spectrum of light. Light exists in many wavelengths and is all part of the electro-magnetic spectrum. Light can take the form of very short energetic gamma rays all the way to very long low energy radio waves. The Cosmic Microwave Background(CMB) is the oldest form of light in the universe and was generated shortly after the big bang. The CMB is important to astronomers and cosmologists because it is widely regarded as a remnant of the big bang. The Big Bang theory is a hypothesis that the universe was once an infinitely dense and infinitely hot singularity. This singularity inflated rapidly in a huge explosion outward. The residual energy left from this explosion is thought to be the CMB. Originally the CMB was a huge blast of gamma radiation that permeated thought the entire universe. Over time as the universe cooled and expanded this gamma radiation was stretched and is now in the microwave spectrum of light. Studying it gives us clues to how our universe evolved from its very early stages to what we observe today.

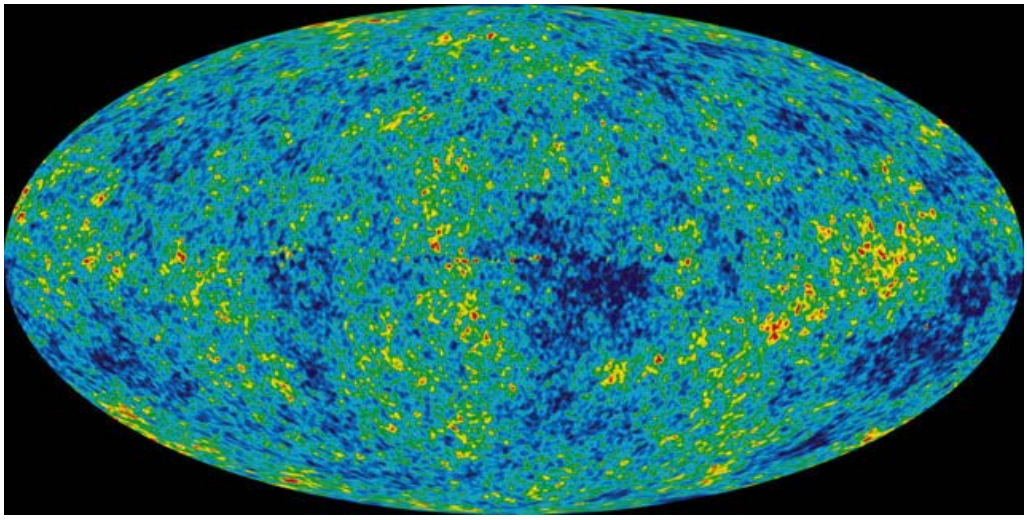

Illustration 3: An all-sky survey image of the universe when viewed in the microwave spectrum

CHAPTER II: ARGUMENTS

The Artist

I will soon completing my third year of graduate school in pursuit of an M.F.A. in Theatre, specifically in lighting design. Throughout my graduate career I have been studying and refining my ability to present interesting and engaging stories as a narrative designer. Prior to coming to The University of Texas at Austin for graduate school I had a very rounded and eclectic background in all areas of theatrical performance from acting, to technical direction and management, to designing and directing. It is hard for me to think of a position that I have not been in for one production or another. It is from this diverse background that I pulled from during the creation of the multiple aspects of this thesis project.

The Beginnings

Ever since I was a small child I have always loved everything to do with space, astronomy, and science fiction. I grew up star gazing and searching for shooting stars under the North Dakota sky. Laying on a blanket staring up at the night sky was one of my favorite pastimes and that wonder and awe of those nights has never left me. Now, years later after a very twisting life path, I found a way to return to use those moments of awe and wonder by reaching out and inviting an audience on a journey.

The Catalyst

In the spring of 2011 I was watching one of my favorite TV shows, *The Universe*. During the episode they mentioned a phenomena caused by the power of gravity to bend light. The phenomena is called gravitational lensing. This sparked an interest in this phenomena and a realization that astronomers were making observations about our universe using the same medium that I have used as a theatrical designer: light.

The Correlation

Astronomy is an observational science. Astronomers study light in all different wavelengths of the electro-magnetic spectrum. This includes, although a very small section of the full spectrum, the visible light wavelengths. Astronomers look through telescopes and use other types of very sensitive equipment that measure many different attributes of light rays. They then take this observational information and dissect it and study it. The attributes and nuances within these light rays give them clues about what they are studying. Whether it be a nearby star or the most distant observable galaxy, it is the information coded within the light given off by these objects that gives astronomers clues and details about the object of study.

The most obvious use of light in theatre is to allow the audience to see the action of the events of a performance. But a carefully thought out lighting design and execution can give and reveal more information than surface depth. The angle at which a source of light strikes an object, color temperature, color, texture, and intensity are all attributes of light that can be adjusted and controlled during a performance. All of these attributes added together and used with intent and precision during a performance can give more emotional and psychological depth to a character, moment, and scene.

In looking at both disciplines in tandem, astronomy and lighting design, the information contained in the light is paramount to both. Astronomers look to light with the hope of knowing more about the object of study. Lighting designers use light to shape the world and reality of a performance and inform an audience. In both cases and professions, the absence of light can be just as informative as the light itself. Light wavelengths that are missing from a distant celestial object's spectrum are just as important to an astronomer as a part of the stage left dark by a lighting designer. Missing or hidden information not contained in the light, is in itself information. The absence of light can in cases be just as informative as light.

Cosmic Photonic What?

While researching light, and its smallest component the photon, a term not normally associated with astronomy or lighting design was encountered, *photonics*. Photonics is the field of study and design of devices and systems that depend on the transmission, modulation, or amplification of streams of photons. This term originated in the 1960s and 1970s with development of optical fibers. Optical fibers are glass filaments that can carry light from one point to another, very similar to a copper wire carrying electricity. These man-made systems use streams of particles of light, the photon, to encode, transmit, and finally decode the information at a receiver.

I am re-appropriating this term, photonics. The current definition of this term is too limiting. The current usage of photonics limits it to man-made systems of light, encoding, transmitting, and decoding information. I assert that all light, whether generated by man, or created through naturally occurring processes has information encoded and embedded in its stream of photons, and are thus part of a photonic system. It is up to the receiver or observer of these streams of photons, and the information contained within them, to decode and find the worth and meaning.

The encoding and decoding of photonic data is the primary function of a lighting designer. Through the artist's dispersion of photons, convey information to an audience. There is a photonic system in place that is carrying information between the designer and the audience.

Astronomers are also part of another photonic system. A distant star radiates various spectrums of light. These light rays and streams of photons travel through space and are recorded by telescopes and satellites looking are various segments of the electro-magnetic spectrum. Astronomers then take all this data and information and start to make inferences and deductions about the light and thus the object that emitted them. They can then start to make comparisons to other objects and the photons they emit and thus gain a vast database of knowledge about our universe.

The northern lights, gravitational lensing, and the cosmic microwave background are all examples of cosmic phenomena that are photonic systems. There is information

contained in the photons of these phenomena that have provided information to astronomers about how our universe works and operates on large scales.

The Boys in R&D

After seeing that episode of *The Universe* I started to formulate a way to use this incredible phenomena of gravitational lensing as a thesis project. The first idea I presented was an art installation that demonstrated gravitational lensing. I made a presentation to the graduate design forum class and received a surprisingly positive response to the project. My peers and faculty members seemed engaged by the topic of gravitational lensing and started asking questions that branched out into deeper subjects about space, astronomy, and cosmology. Cosmology is a hybrid science between astronomy and philosophy. This hybrid field will take observational data made by astronomers and ask deeper questions about what this means to the universe as a whole.

Through this presentation to the graduate design forum I came to two very important revelations that were critical to the further development of this thesis project. The first was that through the explanation of a very technical cosmic photonic phenomena, in a very practical and simple way, I was able to captivate an audience's attention and engage them in a further conversation about astronomy and cosmology. The second realization was that I, as the presenter of the information, was energized and excited by the questions and conversation that resulted from the presentation. It was from this initial presentation about the art installation that the idea of doing a performance lecture evolved.

Once Upon a Time…

The next development was devising a way to convey the of photonic phenomena topics to the audience. I started to remember all those nights spent staring up at the sky and the child-like wonder of approaching something I was fascinated by but had no real understanding of how it all worked. I decided to begin the lecture with a personal story of

my family watching the northern lights. This put the audience in a childlike state of mind, and allowed themselves to go along with this journey throughout the universe.

The most logical starting point was the Northern Lights. This was the phenomena that the little boy in the beginning recalls seeing and is also something that at least some audience were familiar with. The second topic of the performance was gravitational lensing. This topic was slightly more advanced and removed than the northern lights and yet well received. The third topic chosen was the cosmic microwave background. This was by far the most removed and complicated subject addressed in the lecture, but it was also has the biggest ramifications to our understanding of the universe. The intent of this performance-lecture was to inform the audience but to not necessarily answer every question they might have had about light and astronomy. This was part of an effort to perhaps provoke the audience into continuing their own investigation, LAMBDA served as a catalyst for their own self-motivated journey of discovery.

All the World's a Stage

A classroom was chosen as the ideal place for the performance. This was an intentional choice to step away from a traditional place of performance such as a theatre. This was done in an effort to create a hybrid space of both a traditional performance space and a space of institutional learning. In fact, most of the existing furniture in the classroom was rearranged to create the performance space. The chairs in the classroom became the audience seating. The tables in the room became the stage. The movable display board panels became a scenic backdrop and masking for the backstage and the performance control equipment.

Illustration 4: Performer welcoming the audience.

The hybrid space worked as both a performance space and educational space. Lighting booms hung with both LED and conventional fixtures were brought in to provide controllable lighting for the performance. Two large projection screens and three projectors were used to show pre-designed lecture specific video content and animations, these were played back with a computer dedicated to video and sound. High quality audio speakers were also brought into to enhance the audio experience. The lighting control console was then slaved by a MIDI connection to the projection computer allowing light, sound and video to run in sequence with the push of one button. The audience seating was configured to focus the attention at the screen and the stage comprised of tables. All of this was carefully constructed to make the audience question if they were at a performance or a lecture.

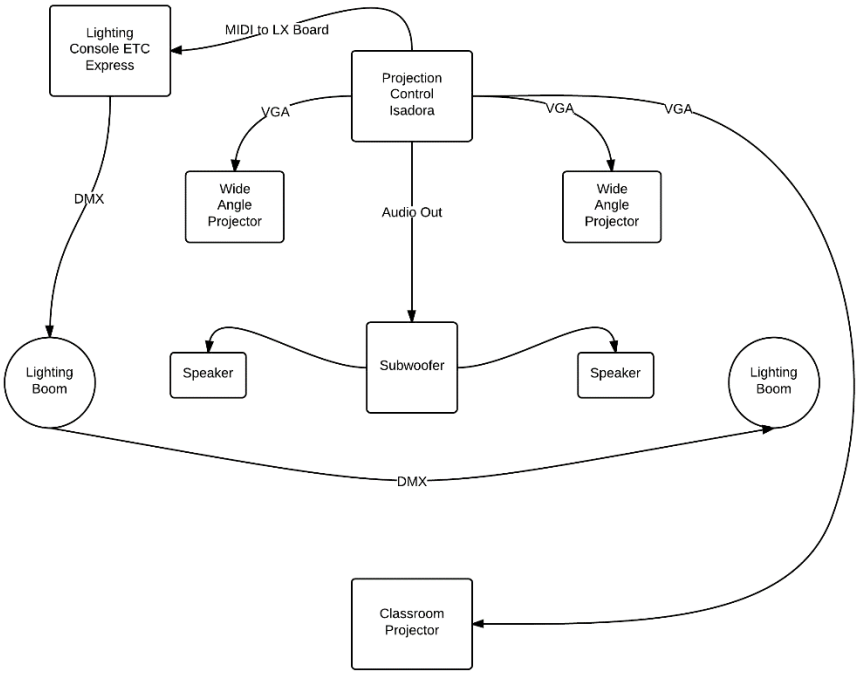

Illustration 5: Diagram of control systems and integration.

Lights, Media, Sound, ACTION!

The lighting configuration for the performance was a combination of conventional fixtures, LED lighting units, and florescent ceiling lights in the classroom. The lights were hung on lighting booms and flanked the stage on left and right. The lighting units were controlled by a lighting control console set backstage. The lighting cues supported the action of the performance by unifying the stage and the projection content. The light cues followed the media and performer, changing color and intensity as needed to direct the focus of the audience.

The media content for the performance was created concurrently with the text of the lecture. The media was at times the focus for the audience over the performer. Other times it became secondary information and the performer was the focus. There was an ongoing and shifting conversation between performer and media. The primary purpose

of the media was to clarify information being delivered by the performer, to move the performance from one talking point to another, and to provide an aesthetically appropriate background for the performance when scientific content was not needed. The media content projected was a combination between original content created specifically for the performance, video clips and animations provided by NASA, and stock footage. All of these videos were edited, adjusted and cut specifically for the projections of this performance.

Illustration 6: Performer gesturing with the projected media.

The sound for the performance was supportive to the subjects and topics being addressed by the performer. Most of the tracks were electronic music that varied in tempo and emphasized the subject matter that was being discussed throughout the performance. The sound design was intended to underscore the performer and never be an extremely present element of the performance.

What's my motivation?

An important part of the performance not to be overlooked is the role of the narrator. This character had the difficult task of telling an emotional story about a little boy with his family and the northern lights and then transitioning to an educational

lecture about the cosmos. Finding the right tone for the little boy, and the science guy, while maintaining the interest of the audience, is challenging.

The costume helped to inform the audience about the character. The performer was dressed in a white short sleeved dress shirt adorned with pens in the breast pocket, a black tie, black pants, black socks, and black shoes. He was intended to resemble a 1960's NASA mission control personnel. The straight-laced perceived appearance of the performer was then juxtaposed by his child-like actions of telling a story and then standing on the tables spinning glowing orbs. These choices subverted our preconceived notions about how science should be presented and how the presenter should look and behave.

Illustration 7: Performer retelling a story from childhood.

But lest we forget

The art installation was not lost in the planning and preparation of the performance. The installation went through several iterations during its design and preparation phases. After careful thought and research of the visual elements of gravitational lensing was designed and executed. Great care and diligence was taken to ensure that the installation constructed and installed to appear as complete, clean, and professional as possible.

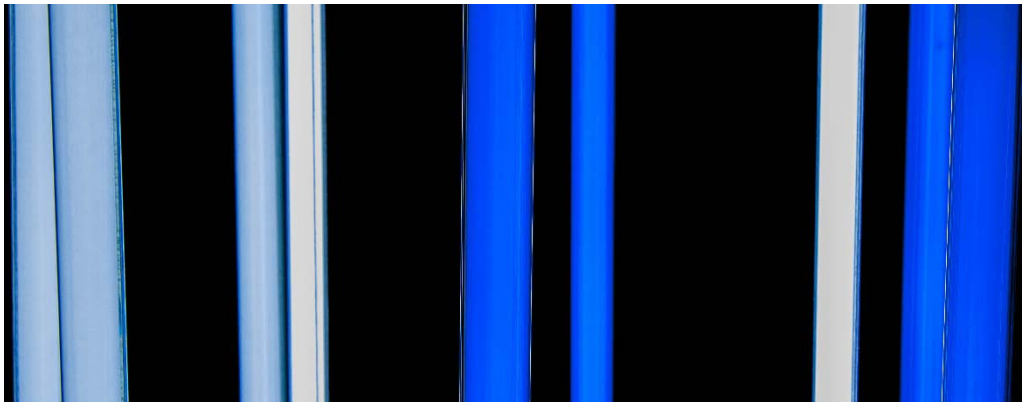

Illustration 8: Close-up photo of the florescent tubes.

The art installation was located in the Brockett Theatre Atrium in the Winship Drama Building. This very tall narrow atrium with skylights overhead was the perfect space for this installation. Already hung in the atrium were four white horizontal metal cloud-like structures suspended from the ceiling structure. These clouds were redistributed thought the atrium ceiling to accommodate the installation.

From these clouds various colored florescent tubes hung down in a vertical orientation held up by clear electrical cords. The tubes varied in color from blue, to light blue, and white. Resting on white boards on top of the clouds were the florescent ballasts needed to power the tubes.

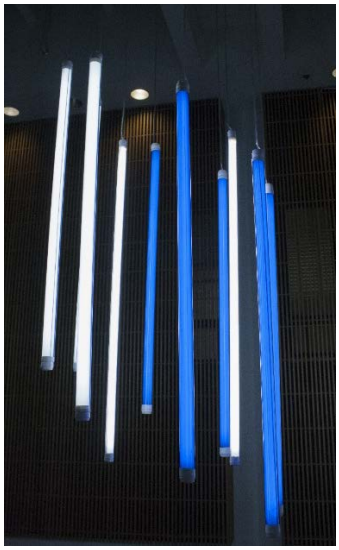

Illustration 9: Florescent tubes hanging from steel cloud.

The tubes were arranged around the perimeter of each of the four clouds. The four clouds varied in the amount of florescent tubes hung from each cloud. The tubes also varied in height from cloud to cloud. The variation of colors present in each cloud, the number of florescent tubes per cloud, and the arrangement of the clouds as a whole in three dimensional space are intended to be abstract representations of gravitational lenses.

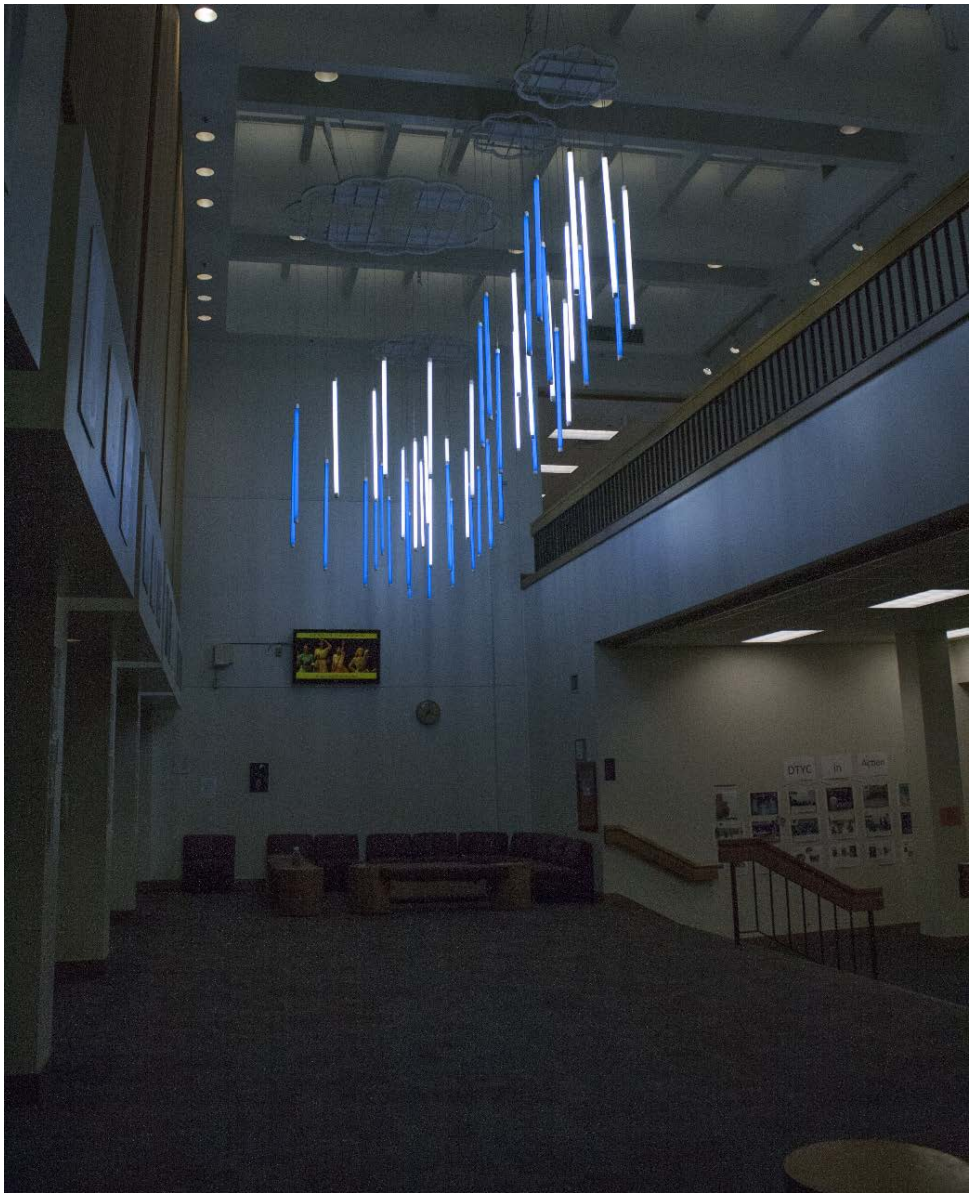

Illustration 10: Full view of installation from ground floor.

CHAPTER III: CONCLUSION

Summary of thesis

I assert that the communication and passage of scientific knowledge, of any subject matter, from one person to another may be a performative event. Furthermore, this method of using live performance and art to spread the information to those not directly involved with the scientific research may be an engaging form of information dissemination.

Reflection of Thesis

THE PERFORMANCE-LECTURE

As with most new performance works, this project was an ever evolving entity. No two performances were ever the same. After each and every performance, changes were made based on audience reaction and comments. Because I was fulfilling all production roles for this performance I was able to assess what was working and not working during every performance. Changes to the script, media, lighting, and props were made daily to refine and edit the performance and aesthetic.

Illustration 11: Performer talking about the early universe.

All of these changes, however small or large, were made to clarify the subject matter without compromising the content and the science behind the cosmic photonic phenomena. It is a very fine line to walk. The first performance used too much scientific jargon causing the audience to disengage. After five performances I was able to dial into a very precise balance between science and performance.

Illustration 12: Light can take a curving path through space.

Audience reactions to this performance-lecture were by and large favorable and encouraging. Multiple people have revealed in the weeks following the close of the performance that they had not only retained some of the information covered in the performance, but had gone on to research their own interests in the sciences and especially in astronomy and space exploration. This was the exact direct and indirect intent of the performance. The direct intent was to educate and impart scientific information to people not directly involved with the research of the topics. The secondary intent was to encourage and rekindle an interest in the sciences.

Illustration 13: Performer demonstrating gravitational lensing with hand props and projection.

THE INSTALLATION

The art installation closely resembled its original design. The clusters of florescent tubes were hung and installed as they were envisioned. From a purely aesthetic view the installation was successful. The care and diligence put into the creation and installment of the installation paid off in the end. The install looked complete and clean.

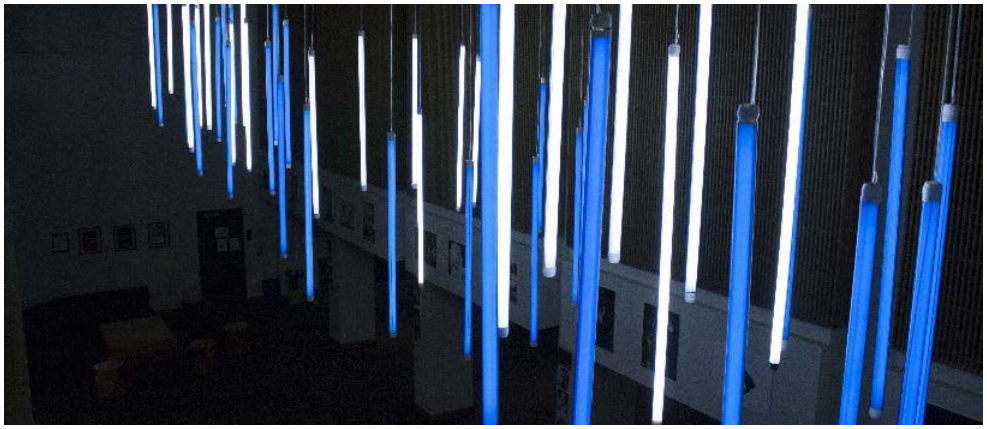

Illustration 14: Installation view from 2nd floor balcony.

The installation changed the way we perceive the pre-existing volume of space in the Brockett Theatre Atrium. This occupation of a space that was normally a void added weight to the installation. The fact that the installation emitted light also helped to change perception. The florescent tubes emitted light that was sometimes obstructed by other florescent tubes. These obstructions cause vertically oriented shadows to appear on the walls of the atrium. These variation of shadows, light, and color on the walls only further emphasized that the installation had the ability to reach beyond the physical occupation of space, much in the same way gravitational lenses have an ability to reach out far from the center of the lens to change the course of a light ray.

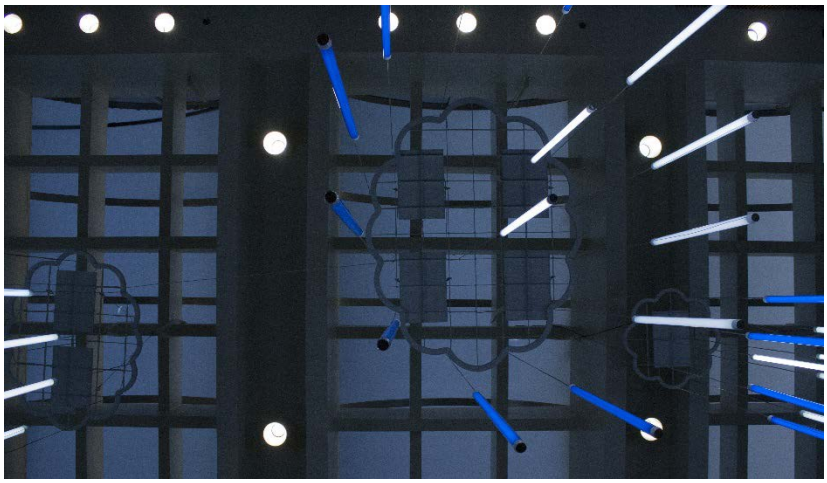

Illustration 15: Installation view from ground floor looking straight up.

The installation, while making perfect logical and aesthetic sense to the creator, left a majority of viewers unaware that a cosmic photonic phenomena was being conveyed. Most of the viewing public responded favorably to its design and aesthetic but did not make any connection with a scientific concept.

In the future, I would context the installation and performance with the simultaneous presentation of related video content to be less vague and more direct with the intent of the installation. A short video could play on a monitor in the same space as the installation describing gravitational lensing, or a series of banners or posters

describing this phenomena would be the most likely elements to add to the installation. Also I would change the actual design of the installation to incorporate a light emitting pathway that would further illustrate the path a light ray can take while being lensed by gravity.

Illustration 16: View looking through the installation from ground floor.

All this aside, the installation was viewed favorably. The installation had so much positive response that it was allowed to be held in the space for a full month. Four times longer than the intended duration of the installation.

Final Conclusion

In this thesis I produced two methods of communicating scientific through a performance and an art installation. The audience reaction asserted that science can be entertaining and engaging when passed thought a medium of art and performance. Considering this project, the next iteration will be more effective, concise, and will convey deeper knowledge to a wider audience.

Creating this performance-lecture and installation was very challenging in all the right ways. I grew as a technician and by learning new technologies, equipment, and software. These are tools that I will need and use in the future of an industry that is always adopting new technologies and new ways of working. As a designer of performance this project put me in a lead creative role and propelled me to value myself as an artist in the field of live entertainment and performance.